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BRANCH OF RESEARCH

MONTHLY REPORT

February, 1935.





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February, 1935

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## APPALACHIAN FOREST EXPERIMENT STATION

### Management-Mountains

Field work on establishment of the Bastian, Virginia, selective logging plots was completed late in the month as was the mill scale phase of the study. Three plots were established of which two totaling 17.73 acres were marked for cutting, the third plot of 9.25 acres being cut over in accordance with common logging practice. On the areas selectively logged the marking reserved an average of 10.4 trees per acre from 10 to 26 inches d.b.h. while the cutting removed an average of 21.2 trees per acre. Approximately 25 per cent of the original volume was reserved.

### Coastal Plain - Pulpwood Study

Mackinney has been continuing the analyses of the data collected in the pulpwood study last summer. New site index curves have been made for loblolly pine from data collected on 160 plots selected at random. The average site index for all plots was 78 feet at 50 years, considerably lower than the site index of 91 feet shown by the plots in the southern pine yield study.

A new volume table for loblolly pine has also been made from trees cut on plots selected for age and density. The values follow those given in earlier volume tables for the same species except in the larger size classes where the present volume table is lower. Further analysis is being made to determine the effects of density of stocking on form.

### Fire Damage - Mountains

A cooperative investigation on the elimination or reduction of dense growths of laurel and rhododendron in order to establish reproduction of desirable species either by planting or by natural seeding has been started by the Pisgah National Forest and the Station. The plan calls for the establishment of 3 series of tests, each containing 12 quarter-acre plots. In each series 2 plots will be checked and 10 plots will be treated, of which 5 will be planted with white pine and 5 left unplanted. All trees on the plots to be planted will be girdled. The treatments are: (1) grubbing and burning of laurel and rhododendron (2) cutting, piling, and burning; (3) cutting, scattering, and burning; (4), cutting 3 foot lanes at 8 foot intervals; and (5) clearing spots 3 feet in diameter at 8 foot intervals.



The National Forest will be responsible for plot establishment treatment, and planting, and the Station for plot examination, analysis of data, and preparation of reports.

### Streamflow and Erosion

On the road bank plantings, sod strips set in furrows along the contours have been one of the most effective methods of holding soil back-slopes. Also pocket plantings of kudzu and honeysuckle have withstood the severe frost action so far this winter. A considerable quantity of leaf litter appears to have been caught and held on the slope by these furrows and pockets. Of the seed of grasses, legumes and herbaceous species sown the only satisfactory control was obtained with orchard grass sown at the rate of 20 pounds to the acre and fertilized with a complete fertilizer; and winter rye, 2 bushels per acre, with the same amount of fertilizer.

General observations to date indicate that one of the most practical procedures in road bank control is to place on the bank a cover of litter or debris from the forest floor and to hold this cover in place by means of furrows, stakes, light brush, or poles.

Direct seeding of pitch pine in May, 1934, has resulted in plants sufficiently well established to withstand frost heaving so far this winter. It is believed that such planting in early summer may escape rodent and bird damage. The seed which had been stratified was planted on plowed strips in broomsedge.

Plowed double lands appear to make a better seed bed than single lands. Observations indicate that the seed should be well covered and that, in addition to planting stratified seed on prepared ground in early summer, success of direct seeding will depend upon being able to get the seed set at a proper depth under the soil. Tests are to be continued with direct seeding on abandoned land and eroded fields during the months of May and June of the present year.

### Fire Weather

The fire weather forecasting service will begin March 1. February ended with a substantial rainfall deficit, the last good rain having occurred about the middle of the month.

The year 1934 ended with a slight excess over normal precipitation. Autumn rains were about normal in amount and distribution and winter precipitation was slightly excessive, though poorly distributed.



## CALIFORNIA FOREST EXPERIMENT STATION

### Forest Management - Pine Region

#### Tree Roots

It is easy to generalize about the unknown. The obscurity surrounding the root habits of even the commonest forest trees has resulted in a number of more or less absurd assumptions concerning the parts concealed in the soil. We speak of deep and shallow rooted species. It is commonly accepted that shallow soils may permit good growth in early life but as the stand grows older, stagnation results from inhibited penetration. Because growth in Sequoia shows no correlation with precipitation during the current year and a better correlation with the precipitation of two or three years preceding the year of growth, and a further accumulative improvement in the relation when ten year records are included, a prominent scientist has assumed that a long period is required for moisture to seep down to the roots of these giant trees. A consulting forester, reporting on a large private tract, explains that during the drought cycle the seedlings have robbed the older trees of soil moisture because the shallower roots of the little trees give them first chance at the moisture provided by the prevailing light showers.

Root study by hydraulic excavation conducted since 1926 at the Stanislaus Branch results in the conviction that such opinions will have to be modified.

The distinction between shallow and deep rooted species appears to be of little significance in this region. There is no evident division of labor between plants in working the soil profile. The superficial soil above a depth of 12 inches is the principal source of nourishment for all seed plants. This top soil has available water and temperatures favorable for growth during only a few weeks in late spring and early summer. By late summer the moisture content goes below the wilting point to depths of 20 inches or more. During the brief growing season all plants compete actively in the shallow richer soil. They pass the dry season by various adaptive devices.

Annuals like *Nemophila* survive the drought in the seed.

Bulbous perennials like *Calochortus* complete growth and fruiting very early and remain dormant while the soil is dry or cold.



Perennial grasses like Stipa elmeri have a generalized diffuse root system, some branches of which penetrate to where the soil is permanently moist.

Plants with underground stems like *Chamaebatia*, *Rumex acetosella*, and *Lithophragma* have occasional sinker roots or underground storage organs.

In the trees, some shrubs, and some perennial herbs, the majority of the root tips, which are in the shallow soil, become inactive. Water to tide the plant over the dry season is obtained from the deeper soil through special deeply penetrating roots, sometimes the tap root but more often sinker branches from the main laterals.

Trees do not continue to extend their roots deeper and deeper indefinitely with advancing age. Expansion takes place in a nearly horizontal plane. Within a few days after germination the seedling must compete with the mother tree and other plants down to the smallest annuals. Within 6 weeks its roots have attained the depths at which greatest activity occurs, and within 5 months the tap root has reached the safety zone at depths of 20 inches or more. Where there is a cover of litter, many rootlets appear in the first or second inch of soil. This is especially true of the Giant Sequoia, as Dr. Meinecke has shown, the main body of the feeding rootlets of this species under normal conditions lying within the upper 3 inches of soil. The cumulative seepage of years is hardly necessary for moisture to become available to the tree.

Trampling, and especially the compacting of soil due to auto travel over the root zone of trees, as well as destructive logging and light burning, may easily result in serious damage, which is the more insidious because its effects cannot immediately be seen.

### Predicting Yields

The implications in the lumber code concerning sustained yield render acute the need for a reliable means of predicting yield in all-aged mixed stands. Fortunately the Station has the accumulated records of over 500 acres of permanent sample plots most of which have been examined at five-year intervals for 20 years. In addition to these records, there are useful inventories of thousands of acres of virgin and cut-over forests.

The manipulation of these records to produce a satisfactory predicting mechanism is an exceedingly difficult and time-consuming task. No completely successful method has even been worked out for pure selection stands, and with 5 species in mixture, the problem is even more complicated. Normal yield tables for even-aged stands previously used are certain to give gross over estimates.



It is believed that the Station's work is now sufficiently advanced to state that a reasonably accurate method of prediction is now available for application to private cut-over lands where the owners petition for sustained yield privileges, and to national forest working circles.

A test of the new method will probably be made this season during revision of the plan for the Eastern Lassen working circle. The greatest difficulty yet to be overcome is encountered in the forecast of mortality. Thus far losses do not appear to be sufficiently well correlated with any measurable factors to enable good predictions of mortality to be made.

#### Forest Management - Redwood

Hallin and Stahelin, with the assistance of from six to ten SERA computers, varying with the number available, have spent the entire time since the first part of November in working up the data collected during the past summer for the redwood logging time-study. Some of the data collected are shown in the following table:

Summary of Amount of Field Data  
Redwood Logging Time Study

Equipment	No. Settings	Total No. trips	Total No. logs	Total Volume	Avg. volume per log
Tractors "60"-775" (with & without wheels)	5	2,408	3,474	5,942,301	1,710
Double drum tractors	3 <sup>0</sup>	146	147	168,871	1,149
Gas yarder	1	266	273	464,000	1,700
Steam High Lead	5	1,607	1,713	3,430,881	2,003
Slack line	2	1,069	1,543	4,328,206	2,805
Total	14 <sup>0</sup>	5,496	7,150	14,334,259	2,005
Slack line & High Lead Swings	4	1,425	2,120	4,263,413	2,011
Loading	6	-	-	-	-

<sup>0</sup>Double drum tractors were also used on some of the other tractor settings.

Preliminary work, such as the preparation of data and entering them on cards, and drawing of maps for the different settings, took until the middle of January. At the present time the data on 3559 trips have been entered on punch cards ready for analysis, nearly 3000 trips have been partially worked up, and curves have been drawn for two high-lead settings with a total of 813 trips.

The yarding time segregations used include

Donkey settings

Choker pick-up  
Out trip (by distance classes)  
Spotting choker  
Choking (by volume classes)  
Pulling slack  
Pulling out log  
In trip  
Placing log  
Unhooking  
Changing lines  
Delays

Tractor settings

Out trip  
Turning  
Hooking log  
Picking up log  
In trip  
Unhooking  
Turning  
Delays

The only results yet available are from the two high-lead settings for which curves have been completed. In these two cases results as indicated in the following table agree with other similar studies in showing a very striking decrease in yarding time per M feet with an increasing volume per trip.

Relation of Log Size to Yarding Time per M Feet  
Redwood Region - 11 x 13 high lead

Volume per turn in feet B.M.	Yarding time per M Feet in Minutes <sup>o</sup>	
	Actual Yarding distance	
	600 ft.	1200 ft
500	15.12	21.64
1000	8.08	11.71
3000	3.78	5.89
6000	3.06	5.13

<sup>o</sup>Including prorata delays, but not changing lines



## Forestation

### Germination

Artificial chilling (stratification) has been used successfully as a substitute for low winter temperatures, which we do not have, with such species as Fraxinus dipetala, Cercocarpus ledifolius and Rhamnus californica. Species of the genus Lathyrus were found to respond very well to hot water treatment. In one instance, scalded seeds of Lathyrus sulphureus yielded 62% germination, while untreated seed gave only 32%. More information has also been gathered on the advisability of fall sowing trees and shrubs.

### Succulent Plants for Firebreaks

At present firebreaks become quickly overgrown with highly inflammable herbs and grasses and must be cleared periodically, a costly form of maintenance. The chief reason for planting firebreaks is to secure a dense, noninflammable, evergreen cover which will assist human efforts in controlling fire at the breaks.

Very modest experiments on this project have been carried on since 1929 with Mesembryanthemum and Euphorbia at Devil Canyon, and more recently with Atriplex semibaccata on the Santa Barbara and other southern Forests. More extensive investigation of succulents, both native and exotic, is proposed with a view to finding the most promising species for field experimentation. In this search it will be necessary to judge the plants according to some definite criteria. The following qualities have been listed by Kraebel to facilitate the rating of species.

1. Low inflammability; quick recovery after fire.
2. High frost resistance; endure at least 18°F, better 10°F.
3. Good drought endurance.
4. Thrift; should grow strongly in poor soil.
5. Prostrate; habit should make dense or "matted" growth.
6. Reproduce naturally in place by seed or otherwise.
7. Root readily at the nodes.
8. Aggressiveness; should maintain itself against invasion of native vegetation, especially of highly inflammable annuals such as the brome grasses.
9. Soil binding ability; for erosion control by deep or fibrous roots.
10. Non-poisonous to humans.
11. Unpalatable to deer and rodents.
12. Non-thorny.

A number of nurserymen and succulent specialists in southern California were interviewed by Bacigalupi. Fourteen species, all but one being of the genus Mesembryanthemum, were selected as most

promising and worthy of trial. The species which seems most promising is Mesembryanthemum (Hymenocyclis) croceum, which possesses the desirable habit of rooting where its nodes touch the ground. The other species investigated fail to meet the requirements in one or more important respects.

## Range Research

### Experimental Pastures

Fencing progresses steadily on the new San Joaquin Experimental Range with CCC crews supervised by the Sierra Forest. Most of the posts have been set along the 13 miles of line required for the six grazing-capacity pastures. These pastures (arranged in duplicate and stocked at three rates, 10, 15 and 20 acres per cow) will be used for measurement of results of 3 intensities of grazing use.

### Quail Census

Considerable interest, inside and outside the Service, centers in the San Joaquin Experimental Range as a field laboratory for possible future studies of quail management. The area is a natural habitat of valley quail. In the region demand for quail hunting exceeds the supply. The possibilities of increasing the "sustained yield" of quail, through management, are unknown. As a starting point for any quail-management studies that may be undertaken at a later date, either by the Station or by cooperating agencies, a knowledge of the approximate quail population in 1935 would be most useful. To obtain this preliminary estimate, a one-day census has just been completed by a group representing several interested agencies, including Renner, Johnson and Parker from the Station; Horn from the Biological Survey; and four members of the local sportsmen's association of Madera. Four CCC recruits filled in the gaps in the skirmish line. Based on a 20-per-cent "cruise" and with several "outlying (CCC) precincts still in doubt," the count of ballots indicates a total of around 1,600 quail on the tract of 3,500 acres.

## Erosion-Streamflow

### Erosion Survey

Field work in measuring the silting of reservoirs as part of the erosion reconnaissance yielded the following data for selected San Diego County reservoirs.



Reservoir	County	Area of Watershed (Sq. mi.)	Original Capacity to Spillway (M-ac.-ft.)	Approximate Loss in Capacity due to Silting in %	Period of Silting in Years
Barrett	San Diego	249.5	36.274	3	13
Cuyamaca	"	12.0	11.6	Negligible	48
Henshaw	"	205.0	203.58	"	7
Hodges	"	303.0	37.699	2	17
Morena	"	119.0	53.7	1	40
Wohlford	"	8.1	7.6	Negligible	40

#### Erosion Control on Burned Areas

Two pairs of watershed erosion control plots, 1/50 acre in area, were installed on the Brown Mountain burn of the Angeles Forest to measure the effectiveness of mustard in controlling erosion. Profiles and gully transects have been measured on each plot after every effective storm, giving a check on amount of detritus caught in silt-boxes, and yielding a basis for correlation of plot erosion with that occurring on similar adjacent hill-sides. Detailed vegetation counts are being made to complete the picture of value of vegetation in retarding erosion. Gleason has designed an unique electric rain alarm that arouses the observer in a nearby shelter cabin when a predetermined amount of rain has fallen during the night, thus enabling the observer to record the action of the rain throughout a 24-hour period.

A survey of mustard cover-crop sown in the fall of 1934 on the Brown Mountain burn showed seed distribution to be excellent. Ten counts made on varying exposures at different elevations showed an average of 445 mustard plants per milacre as against 80 herbs growing naturally in the same area. Average height of the mustard varied from 7 inches at low elevations to 2 inches at 4000 feet.

#### Fire Research

The study of radius of vision from lookouts has been advanced considerably with the completion of the analysis of discovery time data representing 500 observations of test fires in the ponderosa pine type on the Shasta Experimental Forest. Several physical factors controlling the discovery time of fires have been recognized and their effects have been measured. Rate of spread of the fires, distance, atmospheric obscurity or suspensoid concentration,

angle between the sun and the observer's line of sight, and the background against which the smoke is observed are now considered the principal factors upon which discovery time depends in the pure pine type. Under average good visibility conditions it is now possible to estimate discovery time within 5 minutes when the fires are observed against timber or brush backgrounds. Under these conditions, average rate of spread for the first 8 minutes, distance, and the angle between the sun and observer's line of sight are used to determine discovery time. Landscape visibility as measured by the appearance of natural targets is now sufficiently closely related to the visibility of smokes to be a useful indicator of discovery time or distance. Size of fires upon discovery is not a legitimate indicator of discovery time, since size is a function of both time and rate of spread.

### Forest Products

#### Logging and Milling Studies

A preliminary approximation of small-tree margins has been made by shortcut methods from part of the data obtained in the Fruit Growers Supply Company study last fall. It was found impossible to summarize the entire collection of field data before the beginning of the 1935 logging season with the inexperienced SERA clerical help available, hence the unusual procedure of analyzing a "sample of the sample" to meet the persistent requests from the Pine Association for at least a rough preview of the relation between costs and values in the tree sizes now being left under code requirements. The cutting limit prescribed for the east-side pine region is 16 inches d.b.h.

The upper range of tree sizes covered by the study was 63 inches d.b.h. The range analyzed was confined to 88 trees 30 inches d.b.h. and under. The last minimum code selling prices issued by the Code Authority in July, 1934, were used in evaluating the lumber. The actual rough-dry grades produced are the basis of the figures, not green-chain grades adjusted for incomplete manufacture, grading errors, and depreciation. The results are condensed in the table on following page:



Ponderosa Pine, Lassen County  
Fall of 1934

Tree d.b.h.	Cost in pond per m.b.m. (1)		Cost pond to car per m.b.m. mill tally	Total cost (1) per m.b.m. mill tally	Value per m.b.m. mill tally	Margin
	Gross scale	Mill tally				
14	\$9.52	\$7.30	\$13.11	\$20.41	\$17.94	\$ -2.47
16	8.33	6.54	11.83	18.37	17.35	-1.02
18	7.52	6.06	11.20	17.26	17.28	+ .02
20	7.02	5.84	11.01	16.85	17.50	.65
22	6.67	5.71	10.93	16.64	18.02	1.38
24	6.36	5.59	10.86	16.45	18.58	2.13
26	6.13	5.53	10.80	16.33	19.00	2.67
28	5.93	5.50	10.73	16.23	19.32	3.09
30	5.78	5.51	10.70	16.21	19.61	3.40

(1) Costs do not include railroad spur construction or stumpage

The average external yarding distance for the sample of tractor-arch turns compiled was 2960 feet. The mill had 4 bands and a horizontal resaw. The distance of hauling the logs was about 58 miles, part over private railroad and part over common carrier.

The critical diameter in the sample was about 18 inches. This does not mean, of course, that all east-side pine operators are actually paying out more than they receive for the conversion of ponderosa pine trees less than 18 inches in d.b.h. But from the trend of the cost curve, which ascends abruptly below 20 inches in spite of the very scant proportion of smaller trees which this sample contained, one may reasonably infer that, even with better selling prices, operators' profits have nowhere been enhanced to any significant extent by cutting from virgin stands the sizes now being left under the code regulations.

### Forest Economics

#### Taxation

The taxation study which has been made a part of the 5 county land use investigation, by DeVries on detail to this Station from the Tax Inquiry, has developed some striking conditions. One interesting angle is that of State subsidy to mountain and foothill counties.

Most of the school district governments in the foothills and mountains of the Sierra Nevada region are supported entirely by the State. The Wildwood School district of El Dorado County in 1934 received \$1,435.90 from the State to pay for the education

of three children. The assessed valuation of the real and personal property of the entire district was only \$1,120.00. In the Drum school district of Placer County the State pays an amount equal to three times the assessed value of the district in order to enable the district to provide schooling for their six children for one year.

As a rule he who pays the piper has the right to call the tune, but not in California. The State does not control school district organization, and its apportionment is spent entirely by the local residents of the districts. The answer to the excessive cost of schools in these forest districts appears to lie not only in a re-orientation of land use, involving the public purchase of the private property and the removal of local residents, but the State control of school finances and districting.



## CENTRAL STATES FOREST EXPERIMENT STATION

### Forestation

During February Kellogg completed his compilation of information on the major native vegetative types of the Central States. Chapman has made considerable progress in the compilation of his data for the planting survey report.

Experiments by Chapman on scarification of black locust seed as a means of increasing germination and shortening the germination period have shown progress. An Ames type of scarifier frame has been secured, with which he will endeavor to eliminate seed breakage and to improve the technique of scarification.

An initial sample of seed run through the Ames scarifier, designed for sweet clover, suffered about 25% seed breakage. Samples from the unbroken scarified seed have been showing about 2:1 increased germination over untreated seed. A second attempt has been made in which scarification was accomplished by hand by rubbing the seed between two sheets of coarse sandpaper. The germination of this sample compared with untreated seed under greenhouse conditions has shown as high as 1,800% increase in germination of the scarified over unscarified seed during the first week. In addition to increasing the germination per cent, the range of time over which germination takes place was materially shortened.

The scarification experiment will be continued in an effort to perfect a method more satisfactory than the acid of soaking treatment of black locust seed.

### Forest Sites and Soils

Auten spent several days early in the month on the Illinois Experimental Forest area studying soil and site conditions with the view of planning experimental work for the coming field season.

There is great need in experimental soil work for an amplifying unit to be used in connection with the glass electrode in the field. The commonly used apparatus for the determination of pH in soils is open to criticism. The quinhydrone electrode is affected by certain soil constituents, particularly manganese, which change its value; the hydrogen electrode is very slow for routine work. The glass electrode is rapid and free from variation caused by soil constituents. The difficulty with the glass electrode is that its resistance is so high that the resulting

current is too small to measure with any but a very sensitive galvanometer. Such a galvanometer is not rugged enough to withstand transportation in the field. This difficulty may be overcome by the use of an amplifying system, but so far these amplifying systems have given a great deal of trouble because of insulation difficulties, leakage because of air humidity, and fluctuation caused by varying magnetic currents. Auten spent several days in the Physics Laboratory, through the courtesy of Doctor Heil, studying the possibilities of constructing an amplifying unit.

### Forest Management

Upland Hardwoods. The Dubois County (Indiana) cooperative sustained yield project is progressing satisfactorily considering the difficulties involved in the use of C.C.C. men for timber cruising. Because of the short hours of work and the considerable travel involved, only about 1 - 1 1/4 miles average strip per day is accomplished per crew. Six additional crews are being placed in the field at the present time, and it is believed that the field work will be completed on or about May 1. Day, Kuenzel, and Diller have given considerable time to this project during the month, both in the preparation of local volume tables, and in the collection of growth and yield data.

In order to speed up the field work of the several inventory crews, local volume tables were constructed, based on diameter alone. This was accomplished by construction of diameter height curves for each of the important species in each of the several types. Surprisingly close fits were obtained in the construction of these curves. It has been necessary, however, to raise the values for the lower diameters in the black oak-scarlet oak type, due to the short form of the trees and the fact that the original tables were based on 16 foot log lengths. Close utilization for mine props and cross ties necessitated a table which was more in keeping with local conditions.

Sutton, with the assistance of one local man, has continued the establishment of permanent sample plots on the Illinois Experimental Forest. In one instance, chain-wide strips are being established extending from the edge of the timber land into adjacent abandoned agricultural lands to determine the rapidity and character of natural reproduction which comes into these old fields.

The type map for the Fowler Tract on the Illinois Experimental Forest has been completed and photographic reproductions are being made for field and office use. Sutton expects to have the type map of the Hacker Creek Experimental area in Indiana completed by the middle of March. Day and Kuenzel are working up a type classification chart which, when it is completed, will be submitted to other organizations within the region with the object of standard-



izing this type of work. Myer is working up the volume table data secured from the timber cruise of the Sylamore Experimental Forest which Kuenzel and Cochran made in the winter and spring of 1934.

Farm Woodlands. Relatively little has been accomplished on the farm woodland project during this month. Diller summarized his plot data of the 1934 remeasurements. Both Day and Diller are preparing Station Notes covering various phases of the farm woodland management study.

Underplanting of previously grazed hardwood stands with coniferous stock has invariably resulted in complete failure in the Central States. Practically no attempts have been made to use hardwoods for reinforcement planting in this region. As a result of his ~~ecological~~ studies of the environmental factors controlling natural regeneration following grazing, Diller is of the opinion that reinforcement by tolerant hardwoods is feasible if the ground is properly prepared and if the seedlings are mulched during the first season. As a test of this theory, he is planting about one thousand sugar maple seedlings in a beech-maple stand which has reached the open park stage through continuous grazing.

#### Forest Insects

February has been spent on the remeasurement and re-examination of locust borer sample plots in Ohio and Michigan, and office work compiling field work data. The plots at Cambridge, Ohio, have been remeasured and there remain only a few plots in Tennessee and Illinois to complete the season's records.

The mulched black locust plots on the Carnes area at Cambridge has shown some interesting results. During the early spring of 1934 a series of twelve small plots were mulched to determine its effect on the growth of black locust and on borer control. On ten of these plots a hardwood leaf mulch to a depth of about four inches was used. On the other two, a layer of straw was used. A border of about ten feet was mulched around each plot. Appropriate check plots were established in each case. Both types of mulch appear to have a very decided benefit on the black locust so treated.

The average D.B.H. growth of dominant and codominant trees on the leaf mulch check plots was .317 inches, while on the treated plots the growth was .395 inches, an average increase of 24.7%. The average diameter growth on the straw mulch check areas was .245 inches with .272 on the treated plots, an increase of 11%.

Height growth records demonstrated a corresponding difference between the check and treated plots which differed from diameter growth only in degree. The average height growth for the leaf mulch check plots was 2.2 feet, while the growth on the treated

plots was 2.5 feet, an increase of 17.6%. The height growth on the straw mulch check plots was 2.1 feet with 2.3 on the treated plots, an increase of 9.1%.

Soil moisture records were taken on these plots four times during the past summer and although these records are rather meager, they appear to show that mulching tended to increase soil moisture materially. During the driest period of the summer, certain of these plots showed over four times as much moisture on the mulched areas as on those used as a check. The average moisture in the top three inches of soil on the leaf mulch check plots was 13.4% and on the treated plots was 17.8%, an increase of 33.2 %. The average moisture on the straw mulch check plots was 10.2% as compared to 11.9% on the treated plots, or an increase of 16.7 per cent.



## INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

### RANGE INVESTIGATIONS

#### Summer Range

#### Precipitation, Temperature, and Forage Yield

Preliminary results of the analysis of the effect of climate on forage yield at Headquarters, a site 8,500 feet in elevation, as reported in the December monthly bulletin, have been augmented by the addition of similar data from the Alpine substation, 4 miles distant and 10,100 feet in elevation. For both of these areas an unbroken 10-year record of climate and yield was available. Individual effects of the several interrelated meteorological and climatic factors were determined by means of partial correlation.

In analysis, five distinct periods are recognized with respect to plant growth as follows: (1) the entire fall-winter and early spring period, during which soil moisture stores are replenished for the following growing season; (2) from the date snow off to flower stalks in evidence; (3) from flower stalks in evidence to heads showing; (4) heads showing to through blooming; and (5) from through blooming to seed ripe. Active vegetative growth takes place during periods 2 and 3 and seed formation during periods 4 and 5.

Precipitation, when definitely segregated according to the plant growth period during which it occurred, and when correlated with forage yield as measured annually by harvesting correlation plots at the end of the growing seasons, indicated that the amount of moisture in the soil at the date snow off and the amount of precipitation occurring during the active vegetative periods were the two most important factors in promoting growth. A shortage of moisture stored in the soil at the date snow disappeared showed a strong tendency to result in decreased yield. Deficient precipitation during the various plant growth periods showed a similar but less marked effect except during the period of seed formation, when variations in precipitation show very little measurable effect on forage yield. This agrees with the results of European investigators working on crop yields who find that the critical period as regards precipitations occurs during the period preceding heading.

Temperature was found to have a negative effect on yield. Average daily maximum temperature was found to be the best index. During the first three vegetative periods high average daily maximum temperatures are negative, but the effects are insignificant statistically on resultant yield. However, in the last period, increase in temperature shows a highly significant negative correlation with yield. This interpreted, means that even though an increase above normal temperature may and does often increase the rate of growth, it is wasteful growth. Transpiration and evaporation rates are increased and water supplies become depleted without a proportionate yield increase. This effect of temperature becomes more and more critical as soil moisture supplies become less. Near the end of the season, when soil moisture is near the wilting coefficient, high temperature plays a highly important negative role in forage yield.

Variations in temperature and precipitation during the fourth period (heads showing to through blooming) do not seem to have any effect on forage yield. This, no doubt, is because during this period in which reproductive processes are dominant, there is a sharp decline in growth rate.

#### Climate and Plant Growth Snow Recession and Development Stages of Grasses

The date when snow disappears at the higher elevations may be used in predicting for the more important range grasses not only the date at which the early stages of growth will be reached, but the approximate date when flowers will be in bloom and seed will be ripe. Significant correlations can be shown between the date of snow recession and the date at which these various developmental stages are reached. Naturally the date of snow recession determines to a considerable extent the date of inception of growth, but the length of time required to reach later development stages also appears to be more or less fixed. In other words, if growth begins earlier than usual, all subsequent developmental stages are likely to appear earlier than usual, and vice versa.

The effect of "catching up" at higher elevations during the early stages of growth is balanced to a great extent by "losing out" during the later stages of development. For each additional 100 feet of altitude, 0.3 to 0.7 day less is required to reach "flower stalks in evidence" following growth inception. On the other hand, the length of time between "through blooming" and "seeds fully ripe" becomes greater with increase in altitude. Consequently, the period between snow recession and seeds ripe is insignificantly shorter at the Alpine stations (10,100 feet) than at the lower station. The length of this period for Bromus polyanthus at Alpine actually shows an increase when compared with Headquarters (8,850 feet). The average length of this period for Agropyron pauciflorum, Bromus polyanthus and Stipa lettermanii at all stations for 10 years is almost exactly 100 days.



This correlation of the average date snow disappears with the date of seed maturity, if borne out by further study, may be extremely useful to range management. For example, knowing in advance to a reasonable degree of certainty when seed will be ripe on an area which is to be deferred in the current years unit grazing plan will enable a ranger to more effectively plan the grazing management for the remainder of the allotment. Likewise, the possibility of being able to predict the date of vegetative or range readiness of an allotment from observing the average date that snow is off would be a valuable aid to the administrative man.

The date of snow recession is only one of the factors which may be used in predicting range readiness, time to begin deferred grazing, etc. It seems to be of major importance, however, since the trend of the entire season (whether "early" or "late") appears to depend on it. Minor variations in the date at which various stages of plant development are reached can be attributed to the variations and vicissitudes of climate. These variations are in process of analysis at the present time.

#### Spring-Fall Range (Fremont County Burning Project)

##### Survival of Browse Species

Browse species vary widely in their ability to withstand fire, as indicated by recent observations made on the Fremont County burning area. 800 plants each of sagebrush (Artemisia tridentata) a shrub of low palatability and by far the most abundant species on the area before burning, and of bitterbrush (Purshia tridentata) a valuable browse species which also occurred in considerable quantity were examined at random one year after the area was burned. The data obtained show a 100% kill of the sagebrush and an average bitterbrush survival of 34%. Artemisia tripartita, a species closely allied to sagebrush, but of rare occurrence on the area, was found to be sprouting profusely. Other browse species, including Yellowbrush (Chrysothamnus puberulus), snowberry (Symphoricarpos oreophilus), Oregon grape (Odostemon repens), serviceberry (Amelanchier alnifolia), chokecherry (Prunus melanocarpa), snowbrush (Ceanothus velutinus) and prickly gilia (Leptodactylon pungens) were all found to be sprouting to some extent. The percentage survival for these species, however, could not be determined because the parent plants were so completely consumed that no remains of dead plants could be found.

From these results it appears that controlled burning will completely kill sagebrush cover without entirely eliminating other more desirable shrubs. Whether or not sagebrush will seed in heavily on burned over range from adjacent unburned areas is a problem requiring further study.

Palatability of Desert Species

An attempt has been made to determine the relative winter palatabilities of the plant species growing on or near the Desert Range Branch Experiment Station. Data regarding palatability have been collected (1) by observing the degree of utilization after a period of grazing use, and (2) by observing what sheep actually eat when grazing. A series of observations carried throughout the winter seasons reveal the actual choices made by sheep while they are grazing on a range that supports a number of the important forage species. Table I shows the results of these observations for some of the more prevalent species.

TABLE I  
Relative Palatabilities of Principal Desert Forages  
Desert Range Branch Experiment Station, 1932-1934.

Species	Palatability
<i>Atriplex confertifolia</i>	25
<i>Atriplex canescens</i>	35
<i>Artemisia tridentata</i>	20
<i>Artemisia nova</i> (black sage)	80
<i>Chrysothamnus nauseosus</i>	0
<i>Chrsiothamnus stenophyllus</i>	10
<i>Ephedra nevadensis</i>	70
<i>Grayia spinosa</i>	80
<i>Juniperus utahensis</i>	5
<i>Eurotia lanata</i> (white sage)	65
<i>Sarcobatus vermiculatus</i>	10
<i>Bouteloua gracilis</i>	40
<i>Bromus tectorum</i>	30
<i>Hilaria jamesii</i>	40
<i>Oryzopsis hymenoides</i>	85
<i>Poa nevadensis</i>	85
<i>Sitanion hystrix</i>	75
<i>Salsola pestifer</i>	30
<i>Sphaeralcea grossulariaefolia</i>	50

It is of interest that Artemisia tridentata has a palatability of only 20 whereas Artemisia nova (locally known as black sage by the sheepmen) is highly palatable with a relative value of 80. Desert Chrysothamnus species are very low in comparison with some mountain species. Hilaria and Bouteloua are must less sought after by animals on the desert winter range than might have been expected. On the other hand, Oryzopsis is always highly relished, as well as Eurotia, Grayia, and Ephedra nevadensis.



## LAKE STATES FOREST EXPERIMENT STATION

### Annual Investigative Meeting

The meeting this year lasted three days, February 6, 7, and 8, and Zon made a special trip from Washington to attend it. Tinker, Wales, Pierce, Fenger, and Stott represented the Regional Office and Harmon, Walley, and Ball the administrative field force.

Several concrete recommendations were made. The pressing need for the solution of many problems concerned with the production of satisfactory planting stock, as well as the lack of exact knowledge as to what constitutes satisfactory stock, was felt by both research and administrative branches. As a result, it was decided that the Station should undertake some nursery experiments at several of the National Forest nurseries in cooperation with the nurserymen in charge, providing funds can be supplied.

The suggestion was made that the CCC camp superintendents and cultural foremen located near the Experimental Forests should be taken on a "show me" trip over these areas in order that they might become familiar with the experiments under way.

The compilation of a planting manual and a manual covering timber stand improvement practices, which will include the best knowledge of both branches, will be undertaken.

### Forest Survey

Field work was completed in Unit 4 which includes the southern half of the Lower Peninsula of Michigan, an area of approximately 15 million acres. Eleven million acres were covered by the Survey in the month of January. Field work was discontinued the last of February for lack of funds.

### 1934 Fire Statistics

Mitchell compiled the 1934 fire records for the three Lake States. Even though 1934 was a drought year the results were gratifying. Michigan's record, with only 17.7% of its fires going into class "C" and 17.5 acres for the size of the average fire, was especially good and shows unquestionably what ample funds and good organization can accomplish. In Minnesota 36% of the fires reached "C" size and the average fire covered 115 acres. Wisconsin occupied an intermediate position and shows improvement over previous years but at a considerably higher cost per acre than Michigan.

### Sample Plot Posts

The State representative at the Michigan Forest Fire Experiment Station has worked out a type of sample plot post which seems to fit the needs on burning plots. The posts are made of second-hand locomotive boiler tubing which can be purchased at railroad yards for about \$10.00 per ton. After cutting into proper lengths with pipe cutters the posts are set in the ground and filled with sand to about one-half inch of the top. Molten lead is then poured into the space left at the top. The descriptive information necessary for the plot is stamped into the lead cap with a dye.

### Movies Taken of Caribou

Ideus returned from a trip to the Red Lake Game Refuge where he and Professor Breckenridge of the University of Minnesota were successful in taking "movies" of the only remaining herd of native woodland caribou in the United States. Five animals were seen. This is as many as has been seen at any one time in recent years.

### New Public Domain

Moser completed an article for the Minnesota Conservationist on "The New Public Domain - What is it?" In northern Minnesota only 2.4% of long-term delinquent land can be classed as crop land, pasture or other improved land. Twenty-nine per cent is deforested and the balance in forest cover. Forty-two per cent is in aspen. The character of the delinquent forest land is also of interest. Three-fourths is in reproduction, one-fifth in cordwood and only 5% in sawtimber containing two thousand board feet or more per acre.

### Comparative Drought Losses in Plantations During 1933 and 1934.

Survival counts of trees planted on the Huron National Forest planting experiment are now being analyzed. Despite the fact that 1934 was one of the dryest years on record, the survival obtained was infinitely better than in 1933 as shown in the following table for the Gordon Creek plots which was hardest hit of all plots by the 1933 drought.

Year	Survival of Stock One Year After Planting	
	Norway Pine 1-0	Norway Pine 2-1
1933	3%	17%
1934	71%	91%



In 1934 there was actually 2 inches less rain during the growing season and the temperature extremes were worse than 1933 but the distribution of rainfall was better during 1934.

#### Type Map Revised

A revision was made of the Lake States portion of Zon & Shantz' map of the natural vegetation of the United States. Slight changes were made in the boundaries of several types. The chief changes, however, were the insertion of considerable areas of the elm-ash-silver maple type in southern Michigan, and a reduction in the area of the pine forest in Minnesota.

#### Comparative Girdling Tests

Release cuttings in young stands of northern hardwoods overtopped by pin cherry on the Hiawatha National Forest afforded an opportunity for testing out several techniques of doing the work. Girdling by any method was found to be very much cheaper than felling. Girdling, using a draw knife or a chain saw, was cheaper than using an axe or a Syracuse marking tool. The trees cut were small, ranging from 1 to 7 inches in diameter.

#### Seed Studies

The Station has attempted to classify tree seeds according to the type of dormancy which prevents their germination without some treatment. Three general classes are recognized: seeds with impermeable coats; those with permeable coats but with dormant embryos, and lastly those presenting both types of dormancy. This classification is necessary before proper treatments for hastening germination can be worked out. For the dormant embryo type, a period of storage is necessary; for the other type (impermeable seed coat) some form of treatment such as sulphuric acid, hot water, or mechanical scarifying should be effective.

## NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

### Silviculture

Compilation of data for the white pine bulletin is now nearing completion. Recently compiled data from permanent sample plots on cut-over and burned areas in the western white pine type has revealed interesting and valuable information concerning the mortality of reproduction in the first few years following germination. The following table summarizes mortality for six common species.

SPECIES	Year After Germination						
	1	2	3	4	5	6	7
	Mortality--Per cent of Total Germination						
Western White Pine	41	8	4	2	2	2	2
Western Red Cedar	43	10	9	5	5	5	1
Douglas Fir	41	8	5	3	1	1	1
Lowland White Fir	24	13	7	3	4	3	2
Western Larch	56	8	3	2	2	1	1
Western Hemlock	70	9	3	2	1	6	0
Average All Species	46	9	5	3	3	3	1

Greatest losses for all species occur during the first year following germination, emphasizing the desirability of understanding the factors controlling initial mortality. Western hemlock seedlings are extremely subject to early mortality with a 70% loss the first year. Western red cedar and western larch also show severe losses. But more resistant to the factors causing mortality are western white pine, Douglas fir, and lowland white fir. Of these, lowland white fir proves to be most resistant with but 24% of the seedlings dying within the first year following germination. Seedling losses of all species are low after two to three years. It is



interesting to note that of the two most troublesome low value species, one, western hemlock, has a high mortality percentage and the other, lowland white fir, proves to be very hardy and resistant. Also of interest is the fact that for first year mortality the species arrange themselves according to size of seed, the species with the larger seeds being hardier than their associates which have smaller seeds.

Formation of plans and correspondence incidental to ordering planting stock for the Fire River Station arboretum took much of Thompson's time. Planting stock of many new species and varieties has already been ordered and together with replacements ordered for existing blocks brings the total amount ordered to date well over twenty five thousand transplants.

With the completion of the establishment report for the latin square thinning plot established at Deception Creek Experimental Forest last summer and the finishing of preliminary statistical analysis of variations between subplots at the time of establishment, Davis has turned his attention to other matters, recently going to Coeur d'Alene to gather information concerning early history of the Deception Creek Forest and to make plans for work during the coming summer.

### Fire Research

The supervision of fire control planning on Forests has taken most of Hornby's time. By April fifteenth the twelve western Forests will have completed plans. Another plan nearing completion includes two million acres of mixed National Forest, State, and private land in north Idaho, which in plan work were considered as though in one ownership. During the field season the fire wardens of two associations assisted in supervision of mapping fuels, seen areas, and proposed roads. They have done much of the plan work involving their units.

In the past three years the fuels on fifteen million acres have been mapped on the assumption that fires would behave as argued in Hornby's discussion and mapping instructions. Considerable satisfaction is attached to the consistency of behavior exhibited by the few cases available for the following analysis:

#### Initial Rates of Fire Spread, 1934

#### Actual Spread According to Mapped Fuel Classification

##### Cases Discarded:

All fires not attacked within 8 hours after discovery.

All fires attacked within one-half hour after discovery. Rates of spread during very short intervals of time are likely not to be representative, and no travel time shorter than a half hour is set up in plans.

All fires confined to one snag.

#### Recognition of General Severity of Burning Conditions:

Fires discovered between 8:00 A.M. and 4:00 P.M. were called "Day" fires. Those between 4:00 P.M. and 8:00 A.M. were called "Night."

Fires were segregated according to prevailing severity as reported for whole Forests by Gisborne's Danger Meter classes.

Spread occurred Mid-day or night	General severity of burning conditions								
	Serious			Moderate			Low and		
	Classes 6 and 5			Classes 4 and 3			Unknown		
	Rate Spread when Fuel was mapped as								
	H	M	L	H	M	L	H	M	L
Day	21.6	3.6	1.8	8.3	3.0	1.6	6.6	2.7	3.8
Night	9.1	3.4	1.7	6.5	2.3	1.0	3.1	2.0	1.2
Comb.	14.9	3.5	1.7	7.5	2.6	1.3	5.0	2.1	2.3
Number of Cases Included									
Day	16	20	3	22	31	11	18	7	3
Night	19	22	3	19	32	10	14	21	4
Comb.	35	42	6	41	63	21	32	28	7
Classes		83			125			67	
Total number of cases					275				

H = High

M = Medium

L = Low

A considerable number of aggressive spreads listed under "Night" occurred in evening.

"Unknown" includes pre and post-season fires that may have occurred during short periods of severe weather.

Since the average Danger Meter class for a whole Forest includes some areas where burning conditions are worse and some easier, inconsistencies of rate of spread in relation to fuel as mapped must result.

It is also a pleasure to point out that Gisborne's Fire Danger Meter consistently predicted correctly the rates of fire spread to be expected.



The fire protection organization in the western forests of Region One will find the weather summaries that have been recently compiled by the station a valuable aid in fire control. Sets of cards are to be furnished in handy desk holders so that the Forest Supervisors may have before them at all times a statement of the averages and extremes of weather during past years and a statement of the probability of occurrence of precipitation and thunderstorms for each 10-day period during the fire season. Cards have been made for 15 forest stations and the data on temperature, relative humidity, precipitation, number of rainy days, and frequency of thunderstorm days are based upon records varying in length from five to 22 years.

In addition to the card summaries, detailed compilations also will be furnished to the forests showing temperature, humidity, and frequency and amount of precipitation in past years. Such tables should prove valuable for reference and should assist in determining fire control measures necessary to meet all conditions.

#### Range Research

Compilation of various data collected at Miles City during the past field season is now drawing to a close. Based on the data from all quadrats, there has been a reduction apparently due to drought, of 28% in total density including all intensities of use. Grama grass shows the least reduction of any species, with 19%, and bluestem wheat grass is at the other extreme showing a reduction in area of 66%. So far there is poor correlation between use and density reductions. The 28% reduction does not take into account a loss that doubtless occurred after charting work was discontinued early in July. The drouth has continued since that time, so that a substantial decline of total vegetative density is likely to show up in chartings that will be made this spring.

The 60 cows on this experiment have been on feed lots since November and the prospects for grass for calving in April are none too bright at this time. Cows from overgrazed lots have improved in condition somewhat with feeding of about 25 pounds daily of a fair grade of hay.

#### Forest Survey

One major change in compilation methods has been made. Prior to this winter, type information was transferred to the permanent 2" base maps from the field overlays by hand, copying over light-tables. We have found that it is possible to photostat the overlay and the base together, and obtain a legible, accurate map, ready to be colored.

In photostating the maps, the first, or negative "shot" is a reduction to 1" to the mile scale. The second, or positive "shot" is back to the 2" scale, for the Survey record. The result is a permanent set of negatives which are easy to file, and may be reproduced either on the 1" or 2" scale as desired, with one "shot." Additional copies cost 11 cents for the 1" to the mile prints, and 16 cents for the 2" to the mile prints. An order of several hundred townships may be turned out in a few hours. Contrasted with a cost of \$1.50 to \$2.00 each for the hand-copying, with proportional differences in time needed to fill an order, the advantage of the photostating method is readily apparent.

Other experiments in the line of developing time-saving devices have resulted in a template for making the parallel lines required on the map, such as the cross-hatching for pole stands, non-reproducing burns, etc. and the use of fountain pens for inking.

The template is merely a series of straight, parallel slots cut in thin xylonite. Since heavy xylonite is very hard to cut, two of the thin sheets are fastened together to obtain stiffness in the separating strips. The factor of stiffness regulates the spacing of lines and the length of the slots that may be used. Additional stiffness in the templates used for narrow spacing may be obtained by cutting the slots a double space apart. Then when one set of lines is drawn, the template is re-set by means of lines scratched half-way between the slots, and the intermediate lines put in. Vertical and 45° lines scratched on the template facilitate setting the instrument for right-angled vertical and horizontal or 45° cross-hatch.

Fountain pens having very fine sharp points are being tried out for all inking except the drawing of the type lines. Apparently a saving of 10 per cent to 15 per cent can be effected in using these as against the ordinary drafting pens.



## PACIFIC NORTHWEST FOREST EXPERIMENT STATION

### General

R. C. Hall, Acting Director of the Forest Taxation Inquiry, spent part of the month in Portland counseling with legislative committees, forest officers, and others working for forest tax reform. He made headquarters at the Experiment Station but spent most of his time in Salem and Olympia.

Mr. Lawrence Cummings of the Northern Rocky Mountain Station has been here for several days acquainting himself with the technique we have employed on the growth phase of the Forest Survey. At a recent staff meeting he gave an account of the status of the Forest Survey in R-1.

The Director gave a talk on "Conservation" at a recent meeting of the Portland Garden Club. H. J. Andrews spent a day at the University of Washington, giving talks at the Forest Club in the evening on the Forest Survey and at classes on the employment situation and other matters of interest to the undergraduates.

The Pacific Logging Congress, in cooperation with The Timberman, is planning to get out a logging engineering handbook, and this Station has agreed to assist in compiling material on certain topics.

The Twenty-fifth Anniversary of the founding of the Oregon State College forest school was celebrated February 21 with a banquet in Corvallis. Over 500 foresters were present, including the under-graduates. About 20 attended from this Station. Sinclair Wilson of the staff introduced the principal speaker of the evening, President Peavy.

Weekly staff meetings have been held regularly--an institution that is here found very helpful. About half of the hour is devoted to announcements and open discussion of administrative and routine affairs, and the remainder to some current technical phase of our work given by one assigned in advance. This month's meetings, for example, have included such topics as a review of the program of research in forest pathology given by Mr. Lachmund of the B. P. I., a discussion of how to take good pictures in the forests by Mr. Ryan, a professional photographer, and a review of the recent National Resources Board reports presented by Sinclair Wilson.

## Experimental Forests

Office work on the written discussions, tables, and maps in connection with the intensive forest survey of the experimental forests is now well along. These reports comprise the very necessary basic description of these forests and the starting point for the needed management plans.

For the Pringle Falls Experimental Forest considerable work has been done on the reports on establishment of the many plots recently put in. There are now 41 1/2 acres of plots containing 295 mil-acre quadrats.

Isaac and Munger spent a week-end on the Cascade Head Forest, primarily looking for the best headquarters location and planning transportation development. A road crew of 20 has been at work all winter, and is still at work.

## Section of Silviculture

Fire studies - The major project of the month was the writing of a tentative working plan for the cooperative study of the fire weather service in Washington and Oregon. Ward wrote the working plan under the supervision of Morris and Matthews and with the informal cooperation of the local Weather Bureau men. Work on this project will proceed as soon as the plan has been approved by the Washington office of the Weather Bureau.

Matthews completed the instructions for mapping and cruising the Rock Creek area in Coos County, Oreg., and spent several days on the job with the crew in company with Fred Matz of the Regional Office. This area is under consideration as containing a possible natural area or experimental forest or both.

Crombie completed the compilation of the fire danger station records and the records have been returned to the forests. During the month there was correspondence with the California, Southern, and Appalachian Experiment Stations and Region 9 answering their inquiries about the fire danger station equipment and haze meters.

As the result of making a thorough study of Forest Survey data Morris announces the areas of Tillamook and Wolf Creek fires of 1933 as 244,706 and 41,027 acres respectively. These figures should be used in all releases from this date forward. The complete office file on the Tillamook fire should be completed soon.

The final office report on fire depletion and all other depletion except cutting in the Douglas fir region for the Forest Survey has been typed.



## Section of Forest Products

Lodewick spent 11 days on a trip through the Willamette Valley. The first portion was taken up with conferences with members of the Forestry and Farm Management staffs at Corvallis and with Prof. Stafford at Eugene. Johnson joined Lodewick at the end of the fourth day, and a week was spent in trying out plans for output studies in mills of less than 50 M capacity.

Log and shingle prices - The annual statements of log and shingle prices for 1934 were compiled and are ready for distribution.

Douglas fir mill production studies - A few days were spent in analyzing lumber grade recoveries from logs on which data were obtained last fall. The log grade descriptions adopted at that time appear to be indefinite in certain instances, hence do not indicate clear cut separations of value classes.

Preliminary examination of the output data obtained this month encourages the belief that basic output curves can be developed for mills with given equipment and power facilities.

Lumber, lath, and shingle census - During the month 573 acceptable schedules were forwarded to Washington. Letters were sent to 1730 companies calling attention to the fact that their schedules had not been received and to the necessity of submitting them at an early date.

Lumber export statistics - A few days were spent in classifying the lumber export data obtained from the Seattle and Portland Merchant Exchanges.

## Forest Economics

Logging economics - Brandstrom spent the month on detail in Washington, D. C.

Ericson and Wright of the Regional Office, Pagter, Huff and Ramsey of the Mount Baker Forest, and Rapraeger of the Station, marked approximately 200 acres of Douglas fir timber in the Dans Creek drainage (Mount Baker Forest) for selective cutting. It is proposed to offer the area for sale in the near future. The area is predominately mature Douglas fir and western red cedar with an understory of western hemlock. The marked trees consisted mainly of the larger Douglas firs, Douglas firs approaching decadence, and spiked-top cedars.

Rapraeger made a short trip into the pine country of eastern Washington to discuss some contemplated selective logging studies with representatives of the University of Washington, the Northern Rocky Mountain Station, and the Western Pine Association. The University plans one or two studies this spring and requested the Station's assistance in outlining the work.

Land economics - Wilson spent much time during the month cooperating with representatives of regional and state planning boards and commissions on legislation and work programs affecting land resources.

With the help of several temporaries, the job of correlating forest cover to tax delinquency for the 18 study counties has been finished for all but 4. Some data have also been collected on the use of land for agriculture for the census periods 1850 to 1930 to bring out the present and possible future needs for agricultural purposes as that may affect the stability of forest land ownership.

### Mensuration

Substantial progress has been made on the computational phases of all the mensurational projects, such as the spruce-hemlock yield study, the rangewide ponderosa pine yield study, the growth predictions for the Forest Survey, and the permanent sample plot studies, but the studies have not advanced far enough for report writing. Growth predictions for the Survey, however, for the next three decades have been finally correlated with estimated depletion and a final set of tables has been assembled showing the volume balance for the next thirty years.

Some difficulty has arisen in the spruce-hemlock yield study, since an attempt is being made to use a 2.6-inch minimum diameter limit. This limit forces a distortion in the lower ends of all the curves and requires a special adjustment away from the curves obtained by anamorphosis. The difficulty is not a mean one, and we have come to the conclusion that it is better at the beginning to include all trees down to 0.6 inches in diameter. Even then there should be theoretically the same kind of distortion, but it happens at an age lower than twenty years, in which we are ordinarily not interested.

### Forest Survey

The miscellaneous requests from all sorts of individuals and agencies for Survey data and maps have taken practically the entire time of one or two Survey men during the month.

## SOUTHERN FOREST EXPERIMENT STATION

### Olustee Experimental Forest

#### General:

Cuno and Heebink of the Forest Products Laboratory have set up a sawmill on the Olustee Experimental Forest to cut wooden cups. The Southern Station and the Osceola National Forest are cooperating with the Laboratory in a study of the feasibility of making cups from material removed in improvement cuttings and from material unsuited to timber or stave operations and therefore normally left in the woods. The cups are to be seasoned, treated, and followed through a commercial operation. If the process proves practicable the benefit to the naval stores operator will be twofold. He will be able to improve his stands and to provide off-season work for his laborers.

#### Fire:

A stand of dense, young slash pine (established in 1927) on the Olustee Experimental Forest was divided into two parts, each of which was thinned to four densities, besides the control plots. One half was protected and the other subjected to controlled fire. The area is located in one of the most severe fire hazard types, hence, in addition to the experimental value, these plots have considerable value as a demonstration of the possibility of exercising complete control of fire. This value is enhanced by the fact that the plots are immediately adjacent to the Lake City-Jacksonville highway.

Five replications of the test of the effect of a controlled light fire in a one-year rough on one-year-old longleaf seedlings were established. What seems to have been a very simple yet satisfactory method of evaluating the severity of fire attained was used. On each of the one-tenth acre plots 20-25 slash pines ranging from three to fifteen feet in height were stuck in the ground and pruned to heights of 1, 2, 3, 4, and 5 feet. As late as two to three weeks after the fire the degree of defoliation was plainly evident. While measurements are not yet completed, casual observation indicates that the seedlings most liable to escape death are those in favored positions relative to the fuel hazard.

#### Fire and Soil Studies:

Studies of wilting coefficient on burned and unburned soils are being continued and fully stocked stands of slash pine seedlings are being established on these same soils.



Dr. Tissott of the Florida Agricultural Experiment Station, who is cooperating with the Station in this Study, has completed a census of the microfauna from soil on four burned and unburned areas. These data will be analyzed and correlated with the porosity and penetrability of the same soils.

Heyward and Barnette have resumed work on the carbon-nitrogen ratio of the top layer of pine forest soils in the region. The ratio is being obtained for litter, the F-layer, and A1 horizon.

A Foxboro 3-bulb remote control thermograph has been mounted in a portable fireproof shelter. The instrument will be located at desired plots within burning areas and temperatures at various depths within the soil will be determined.

#### Naval Stores:

The problem of the best method of chipping fast-growing large-crowned slash pine, with which the Station has had little previous experience has become urgent, and will become more urgent in the future due to the large areas of this type of timber in southern Georgia that are just coming into production. In view of the fast growth rate of these young trees there is reason to doubt whether the 1/2 inch deep chipping advocated for the trees grown under less favorable management that have been tested in northern Florida will prove sufficient for optimum damage. Liefeld has established two experiments on the Slash Pine Farms properties at Stockton, Ga. to test various heights and depths of streak. Depths of streak being tested are 1/4", 1/2", 3/4" and 1 inch, and heights tested are 1/4", 1/2", and 3/4". Included in the experimental set-up are measurements necessary to determine the optimum height and depth as they vary with size of and growth rate.

Liefeld and Murray are installing on the Osceola National Forest a test of the economic feasibility of a salvage working of back-bars of trees that have been worked through the second and third faces. The relative yields of American and French faces are tested, as well as various combinations of face and back-bar widths in an attempt to arrive at optimum combinations and minimum requirements.

#### Protection - fire:

Remeasurements were completed on the plots in Lot 284 of the Cogdell fire. These plots were permanently established and individual tree measurements were taken. Analysis of these remeasurements will be made to determine the comparative descriptions of trees as between examinations shortly after and one year after a fire. It is hoped that the relationship between tree description and death or survival can be established so that estimates of probable mortality can be made shortly following a fire. One noteworthy observation is the tendency in a great many cases of adventitious needle

development to assume normal appearance within a year after complete defoliation and killing of the terminal bud.

### Forestation:

Wakeley and Olsen finished all but one day's work on actual planting of experimental plots at Alexandria for the year, bringing the total number of experimental plantations, including those for March 1, to 482; and the total number of trees to approximately 350,000. Wakeley reports an instructive day, February 18, spent at the Stuart Nursery extractory with Mr. Rietz, of the Products Laboratory. They ran tests of the kiln and discussed improved designs and schedules based on the Laboratory's knowledge of heat-engineering and the Station's knowledge of cone moisture content and behavior.

Wakeley, together with Drs. Synder and Craighead, examined what they consider to be a serious problem: namely, colonies of red town ants (*Atta*) which have defoliated approximately 60 acres of longleaf pine seedlings on the Evangeline District. Burrows were excavated and found to go down 6 feet, and run 50 feet or more to other outlets. They felt that carbon bisulphide could be only a partially effective remedy, and decided to attempt arsenate of lead poisoning. At the Stuart Nursery Humberman practically completed measurements and computations on all 1934 tests and selected the area to be set aside for the next ten years' experiment, especially in fertilizers.

### Financial Aspects:

R. R. Reynolds arrived in New Orleans February 27, preparatory to spending several weeks in working up his selective logging study of second growth short leaf and loblolly pine in Arkansas.

A study of pulpwood production from round and worked-out longleaf pine in North Western Florida, conducted by Worthington and Yencso, has shown the following results:

1. Utilization. Based on volume outside the bark the utilization percentage for round timber averaged about 70 per cent in trees from 6 inches to 14 inches DBH. Owing to the discard of portions of the turpented butts, the utilization percentage for the worked-out timber based on the total tree volume outside the bark was from 7 to 8 per cent less.

2. Time required and costs of cutting. The time required to cut round pulpwood timber into bolts five feet in length ranged from 6.65 man-hours per cord of 160 cubic feet for trees 6 inches in diameter, to 3.98 man - hours for trees 14 inches in diameter. No pulpwood cut from trees of these sizes was split.

These time requirements include penning time (a pen is a crib of pulpwood six feet in height with two bolts to each layer). Due to losses in volume from discarding turpented butts and to additional time for trimming turpented butts which were fire-scarred, the cutting time for turpented timber was greater in the same diameter classes, ranging from 7.42 man-hours per cord of 160 cubic feet for trees 6 inches in diameter to 4.25 man-hours for trees 14 inches in diameter.

Pulpwood cutting is done on a piece-work basis. The average earnings per man was \$0.13 per hour for his labor. Charges for tools which the cutter furnished, \$0.017, and the cost of supervision, \$0.009, increased the average hourly cost to the contractor to \$0.156 per man. With this average wage rate the cutting cost of round longleaf timber ranged from \$1.04 per cord of 160 cubic feet for trees 6 inches in diameter to \$0.62 per cord for trees of 14 inches in diameter. For turpented timber the costs were \$1.16 and \$0.66 per cord for trees of the same diameters.

3. Pulpwood Trucking. One and one half ton trucks were almost universally used for pulpwood hauling. No differentiation of trucking costs by tree sizes was attempted. The average volume hauled per load varied in the different operations. One operator hauling a distance of 26 miles, about one-half over pavement, carried an average of 152 cubic feet of wood (including bark), or about 1 1/3 cords of 160 cubic feet. Loading and unloading cost averaged \$0.17 per cord of 160 cubic feet and trucking cost was \$2.51 per cord. The total truck transportation cost was \$2.68 per cord.

### Forest Survey

#### General:

The interpretive phase of the Forest Survey was definitely initiated during the month with the assignment of Winters and the transfer of F. A. Ineson from the administrative organization. Ineson reported February 16. In this phase of the work, an attempt will be made to correlate the findings of the inventory phase with existing and anticipated economic conditions in order that policies can be formulated for the effective use of land suitable for forest production. Several conferences were held to formulate policies and projects.

#### Inventory:

Exceptional progress was made by the field crews during the period from January 21 through February 16. A total of 11,652,000 acres was surveyed by twenty-five crews working in the five following listed states:



Arkansas	1,942,400	acres
Louisiana	5,385,600	"
Mississippi	2,477,600	"
Missouri	925,600	"
Texas	920,800	"
Total	11,652,000	"

If the progress continues at the present rate, Mississippi on April 1, will become the first state in the Union to be completely covered by the Forest Survey; the first unit in Texas should be completed by March 15, and another unit completed in Louisiana by April 1. Work has been initiated on the last unit in Louisiana.

The economic phase of the work was further developed. Two conferences were held with Mr. W. D. Durland, forester for the Missouri-Pacific, and it is expected that we will be able to obtain considerable assistance from railroad records.

Postcards were sent to 2,482 Houston, Beaumont and Port Arthur, Texas families to obtain information on the fuel use of urban families. The reply cards are now being received and they indicate that 38 per cent of the families use wood in some manner. Of these, 8 per cent use wood for cooking only, 63 per cent for heating only, and 29 per cent for cooking and heating. This survey will be followed by a house-to-house sampling to determine the quantity of wood used by each family and type of use.

Junior Forester Smith, spent most of the month analyzing the results of the forest meter survey of Unit #1, Georgia. The early indications are that this method, in conjunction with the line-plot system, may prove valuable in determining trends which take place in the future. Tentative plans call for a check survey in Florida Unit #1.

#### Classification:

Plans were completed for the duplication of approximately one million punch cards used in the tabulation of the data in order that one set may be filed in fire-proof storage. Tables were completed for the pulpwood release of Mississippi Unit #2. Work was initiated on the tables for a preliminary report on the Norris Dam Watershed for which Davis is now preparing an outline.

#### Presentation:

Two Survey Releases, "The Supply of Pulpwood in Survey Unit #1 Florida" and "The Supply of Pulpwood in Survey Unit #1, South Carolina" were completed and mailed out during the month.

The total land area of the Florida Unit is slightly in excess of nine million acres, of which approximately 77 per cent is designated as forest land. Turpentine pines (longleaf and slash) comprise about 67 per cent of the total forest area and hardwoods make up nearly 24 per cent of the remainder. At least 20 per cent of the forest area bears uncut stands of second-growth timber of saw-log size. "It was estimated that the total growing stock 6 inches d.b.h. and up, expressed in cords, is 45,063,000 cords. Of this growing stock, 23,336,000 cords are in pine species and 21,727,000 cords are in hardwood species."

In contrast to the Florida Unit, only 58 per cent of the 5 million acres in the South Carolina Unit was recorded as forest land, and of this total area, 41 per cent consisted of non-turpentine pines, and 27 per cent of the hardwood group. Nearly 45 per cent of the forest area bears stands of second-growth timber of saw-log size. Loblolly pine was found to be the most important among the non-turpentine group inasmuch as it comprises 78 per cent of the total cordage in this group, which in turn makes up more than 72 per cent of the total pine cordwood volume. "It is estimated that the total growing stock 6 inches d.b.h. and up, expressed in cords, is 34,604,000 cords of which 17,451,000 cords are in pine species and 17,153,000 cords are in hardwood and cypress."

#### Forest Ecology:

An occasional paper entitled "Root Habits of Longleaf Pine Seedlings" by L. J. Pessin was issued. Dr. Pessin pointed out the difference in the rate of growth between long-leaf pine seedlings and the majority of other pines. The former remain stunted, especially under adverse conditions, for as many as thirteen years or more, during which time they are hardly distinguishable from surrounding grasses. Experiments were conducted whereby seedlings in their 13th growing season were excavated in two milacre quadrats, located on similar sites, in which the densities were 185 and 24 seedlings per milacre, respectively.

Results obtained from the experiments indicated that the density of stocking not only influences the size of the stem, but also the size of the root system; the heavier density tending to retard growth perceptibly at both extremities. Dr. Pessin likewise pointed out that tap root growth immediately following germination, is far in excess of stem growth; but that it slows down when the latter commences. A final interesting observation was made concerning the absence of mycorrhizas in these tests.

#### Forest Entomology:

On February 1, Dr. Thomas E. Snyder gave an address before the Mississippi State Engineering Society, at Jackson, Miss., on the

control of termites. Inspection of the wood preservative tests of the Mississippi State Highway Department at Jackson was made.

Two students of Loyola University, working under FERA, reported on February 12 that work on a map showing the location of termite infested buildings in New Orleans was progressing.

On February 23, Dr. Snyder and Dr. Craighead sailed for Panama to inspect cooperative termite tests on Barro Colorado Island in Gatun Lake. These tests, installed in 1924, include buildings and furniture constructed of timber impregnated with chemical preservatives, sections of telephone poles and other timbers. In addition, tests are under way of docks, bridges, water tanks, watch towers and other buildings constructed of termite resistant, untreated timbers. Also, there are tests of poisons for wood pulp and fibre boards in panel ground exposures and as panels in specially constructed buildings. Metal termite shields or mechanical barriers on buildings are under observation, both on Barro Colorado Island and elsewhere in the Canal Zone. These tests constitute a part of the International Termite Exposure Tests begun in 1929 in cooperation with the Forest Products Laboratory and foreign governments. It is hoped to supplement these tests by others to be installed near New Orleans, if funds permit.

#### Forest Pathology:

An occasional paper entitled "Slash-Disposal Methods in Logging Shortleaf Pine" by Paul V. Siggers was issued. Mr. Siggers discussed the comparative advisability of various methods of slash disposal with respect to their bearing on fire hazard and regeneration. As a result of tests made on four quarter-acre plots, it was discovered that the best method of disposal was the simplest: namely, to let the slash remain where it fell; for although the method of piling and burning reduced fire hazard, it created a soil condition unfavorable for the regrowth of seedlings, and whereas piling of slash without burning effected some elimination of fire hazard, it retarded decay to such an extent that the ground used for piling (some 10 to 15 per cent of the total area) remained unsuitable for regeneration. A third method, that of lopping and scattering, neither retards nor accelerates decay; hence it was found to be of little use. Cost of operation in all three methods was indicated as an important factor in their infeasibility.

Hatfield reports that considerable culture work was done, and two progress reports (not for publication) were prepared on the blue-stain project. The blue-stain card index is being corrected and enlarged.



## SOUTHWESTERN FOREST AND RANGE EXPERIMENT STATION

The annual meeting of the Region 3 Investigative Committee was held in Albuquerque January 22 and 23. The Regional Office was represented by the following branch chiefs: Quincy Randles, Forest Management, presiding, Stanley F. Wilson, Operation, M. M. Cheney, Lands, D. A. Shoemaker, Range Management. The national forests were represented by Supervisors Fred Winn of the Coronado and C. R. Dwire of the Lincoln. Representatives of the Southwestern Forest and Range Experiment Station were Director G. A. Pearson, Hermann Krauch, B. A. Hendricks, H. O. Cassidy, E. M. Hornibrook, R. H. Canfield, Fred N. Ares, Arthur J. Riggs. Forest Pathologist Dr. W. H. Long, Bureau of Plant Industry, and Research Biologist Dr. Walter P. Taylor, Biological Survey, were also present.

Compilations and report writing are occupying practically the entire Station personnel. On account of the large number of temporary appointees, the Tucson office space has been taxed beyond its capacity. One room has been rented off the campus. A corps of computers is engaged at the Jornada headquarters and another at Fort Valley.

Copious rains and snows during January and February have gone far toward restoring the water balance throughout Region 3. At Fort Valley the total precipitation for the 2 months was 7 inches and at Parker Creek 9 inches.

### Forest Management

Junior Forester Harlen G. Johnson has submitted a report giving the results of a stand inventory of four sections in the Fort Valley Experimental Forest. Each section is represented by 100 1-acre plots on which all trees down to 4 inches d.b.h. have been measured.

Lexen is in the Washington Office working over his growth figures on some 400 1-acre plots whose records of increment and mortality cover a period of 20 years. Net volume increment has been classified according to volume and average diameter of residual stand. Some adjustments still need to be made for site and distribution of growing stock.

Hornibrook has practically finished revising his volume table for ponderosa pine. This table, prepared according to the latest technique developed in the Washington Office, is especially adapted for use on sample plots. A statistical analysis of the data confirms the validity of the long-established practice in Region 3 of

employing separate tables for "yellow pine" and blackjack".

Krauch has submitted a preliminary report on reproduction of Douglas fir. The field work covers three seasons. Instead of following the old method of staking out plots and waiting for development, Krauch placed the whole experiment under control, as far as that was possible. Plots were laid out in series giving varying degrees of root competition and shade from old trees. In open situations artificial shades of varying density were employed. Different kinds of soil treatment and litter were compared. One complete series was protected against rodents as well as cattle, another against cattle only, and a third was open to both rodents and cattle. Seed was sown in 1932, 1933 and 1934. All sowings, including the dry summer of 1934, have given effective germination. The outstanding conclusion thus far is that rodents dominate the whole picture. Where rodents are excluded, seedlings have been obtained under nearly all treatments, while without rodent exclusion other treatments have been without avail. Substantial numbers have survived 3 winters, thereby tending to refute the former theory that winter was the most critical season. Thus far, no evidence of grazing damage has been found; on the contrary, the indications are strong that, as in pine, controlled grazing is beneficial in checking luxuriant herbaceous vegetation.

### Range Investigations

#### Jornada

John T. Cassady has been temporarily assigned to the Indian Service to take charge of a range survey of some 2 million acres of Pueblo range lands in northern New Mexico.

A small mountain lion was killed on Black Mountain by a Biological Survey hunter. The Survey is now attempting to exterminate the rest of the lion family in order to protect the few mountain sheep in the San Andres Mountains of the Jornada.

The Jornada is experiencing one of the droughts which characterize the arid sections of the Southwest. The average annual precipitation, based on a 20-year record, is 8.96 inches, and for July, August and September it is 4.66. In 1934, the corresponding figures were 5.18 and 1.77. However, an unusual fall of 1.24 inches in May helped the forage growth considerably. The lowest preceding record (1917) was 3.54 annual and 2.34 for July, August and September. In this instance the three summer months of the preceding year received only 2.58 inches. Since in the past, dry years have come in pairs or series, we will be fortunate if 1935 is up to the average. The 1934 summer forage crop (after July 1), was estimated at 17 per cent of normal. This, together with remnants of old feed, has a theoretical carrying capacity of 325

head. By supplemental feeding, the cooperator expects to carry nearly 1,000. A good winter crop of weeds is helping the feeding situation.

The effect of past use on forage production in a dry year is illustrated by five pastures, two of which have been conservatively used and three heavily used over a long period of years. In the two conservatively-grazed pastures the forage crop produced in 1934 was estimated at 19 and 30 per cent, whereas in the other three it was 10, 10 and 13 per cent.

In a clipping experiment begun in 1925 and designed to simulate different degrees and frequencies of grazing, the most conservative utilization, namely, clipping to 2 inches at the end of the season, resulted in the least decrease of density. Since, however, even with this degree of use the loss was 41 per cent it may be concluded that any grazing which removes all of the cover is detrimental to the range. In conservative grazing practice a considerable portion of the grass remains through the winter and spring, but large areas may be grazed clean by March 1 and these areas are likely to be the same ones year after year. The management plan of the Jornada calls for leaving a reserve of 15 per cent to maintain plant vitality, plus a 25 per cent reserve at the close of the grazing season (July 1) for use in case of drought. It has developed that such reserve as exists is usually localized rather than distributed uniformly. In the light of this experiment, the primary purpose of a reserve should be to maintain the range. To attain this end, more or less uniform distribution is required, or, failing in that, stocking should be light enough so that relatively small areas will be grazed clean even at the end of the grazing season. A report by Canfield on this study is being revised for publication.

#### Erosion-Stream Flow

The heavy rains of January and February have brought out the best "annual crop" of recent years. In the semidesert savanna type in the basin around Roosevelt Lake the ground is now thickly carpeted with filaree, crinkle weed and other winter annuals. However, the effect of soil deterioration on the abundance and growth of annuals is quite noticeable even during this period of favorable rainfall. On steep, bare, eroded slopes, such as those at the Summit Erosion Plot, annuals are in some instances entirely absent. The few which have come up in such places have made little growth. On moderate to gentle slopes where topsoils have not been entirely eroded and on fans built up of eroded materials which have been washed from the steeper slopes the annuals have made good growth. Annuals growing on topsoils are two or three times as large as those growing on soils from which topsoils have been partially or entirely eroded.



At the Summit Erosion Plot the number and size of annuals growing on steep south slopes have been increased on one small watershed by the installation of small contour erosion checks. These small checks, which are built of hardware cloth, are about 4 inches high and are spaced about 4 feet apart. There are many more annuals at this on portions of the slope where erosion has been checked in this manner than on unchecked portions. Also, the annuals are much larger in size on the checked portion of the slope. The increased numbers and sizes of annuals on the checked area is attributed to an increase in the amount of soil moisture.

On bare, steep slopes the surface run-off even from winter rains is considerable, as shown by the run-off from small lysimeter areas (500 square inches) which have a slope of 25 per cent. Total precipitation for the past winter period, November 16, 1934, to February 1, 1935, was 5.03 inches. On two lysimeters which had 13 per cent of the ground surface covered by grass the surface run-off for the period amounted to .25 inches or 5 per cent of the precipitation. The surface run-off from two other lysimeter areas with a grass cover of 8 per cent amounted to 1.61 inches or 32 per cent of the precipitation. From two lysimeter areas which were entirely bare 2.72 inches or 54 per cent of the rainfall ran off. As a result of the high percentage of run-off on the bare eroded slopes very little growth of annuals can be expected, particularly during years of unfavorable rainfall. It is expected that the contour checks by conserving soil moisture will aid in the natural revegetation of perennial grasses on the steep slopes.

## MANUSCRIPTS

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The effects of intensity and frequency of clipping black grama and tobosa grass on their density and yield. (Proposed Forest Service Bulletin).

Culley, Matt J.

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Humphrey, R. R.

Grazing in relation to burro-weeds on ranges in southern Arizona. (Proposed article.)

Little, E. L., Jr.

Drymaria, a serious poisonous plant in southern New Mexico. (Proposed article.)

Little E. L., Jr., and  
J. G. Keller

The reptiles and amphibians of the Jornada Experimental Range. (Proposed article.)

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Some factors influencing the yield and mortality of ponderosa pine. (Journal of Research.)

Pearson, G. A.

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